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Title: **VARIATION OF STRIKE INCENTIVES IN DEEP REDUCTIONS**

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VARIATION OF STRIKE INCENTIVES IN DEEP REDUCTIONS

Gregory H. Canavan

Deep reductions shift weapons from military to high value targets, where the dominant cost for striking first is reciprocal damage to one's high value targets. Thus, the bulk of the first strike cost is proportional to the preference for the survival of value. The resulting first strike costs are above those of inaction, so there are no strikes for the reductions studied. This conclusion should be insensitive to variations in key preferences.

This note studies the sensitivity of strike incentives to deep offensive force redctions using the exchange and cost models derived and discussed in a companion report[1] and decision logic discussed in earlier papers.[2] As forces fall, weapon allocations shift from military to high value targets. The shift is half complete at about 1,000 weapons; by 500 weapons, first and second strikes are almost totally on high value. The dominant cost for striking first is that of damage to one's high value targets, which is generally almost total, so the bulk of the first strike cost is proportional to the preference for the survival of value.

Changes in military costs are small, so total first strike costs change little. The resulting costs at decision nodes are well above those of inaction, so there are no strikes for all offensive reductions studied. The dominant cost for striking first is proportional to the preference for survival of high value, and there is a wide gap between that cost and that of inaction, so this stability should be insensitive to reductions in the preference for survival of high value.

Parameters. The principal inputs to the calculations are forces and preferences. It is assumed that the two sides U and P have equal forces, of which half are survivable. They start at current levels and are reduced by stages to a few hundred weapons. Each sides' objectives are represented by three preferences (L, K, V), where L is U's usual preference for damage to P's military relative to preventing damage to its own military targets, K is U's preference for survival of its own high value targets relative to survival of its own military targets, and V is U's preference for damaging P's high value targets

relative to the survival of its own military targets, so that V/L is U's relative preference for damaging high value versus military targets.

None of these parameters are known with precision. It is generally assumed that a non-aggressive strong side could be characterized by L ≈ 0.1 to 0.25; more aggressive sides would be represented by larger L. If U places high value on the survival of its high value or urban targets, it should have K > 1. If U is not interested in damaging the other's high value, it should have V ≈ 0. For nominal conditions, it is assumed below that both sides have preferences (0.5, 2, 1). Sensitivity to other values is discussed below.

Through exchanges and the minimization of first strike costs, these parameters determine the two sides' allocations of first and second strikes to missiles, military, and high value targets. The process and generic results are discussed in the earlier report. Here, it suffices to recall that (f, g, h) = the fraction of U's (1st strike on missiles, second strike on military, 1st strike on military targets).

Results. Figure 1 shows the variation of allocations with L. f is about 0.25 throughout as U's strike allocation does not change with offensive force size. g and h fall from ≈ 0.8 at large weapons (W) to zero at W ≈ 500, passing through 0.5 at about 1,000 weapons. Thus at large W, targeting is largely against military targets; at W < 1,000 is primarily directed to high value.

Figure 2 shows the resulting first and second strikes, which reflect the above changes in allocations. Both fall in parallel with W, with the second strike remaining about 80% of the first. Figure 3 shows the decomposition of these first and second strikes into the strikes on military and high value targets. At large W, most of both first and second strikes are on the 1/k ≈ 1,000 military targets assumed, as it only takes a modest number of weapons to saturate the 1/v ≈ 100 high value targets. However, the strikes on military targets fall roughly linearly with W to ≈ 0 by W = 500. Strikes on high value targets fall more slowly, as weapons are shifted from lower value targets to them as weapons become scarce. By W = 500, essentially the whole strike is on high value.

Figure 4 shows the components of U's cost for striking first, C_1. At large W the main costs are that of damage to its own military forces, $C_{1ms} \approx 0.8$, and to its own high value, $C_{1vs} \approx 2$, which give a total first strike cost of $C_1 \approx 2.8$. The strike on high value in

Fig. 3 is 300-500 weapons, which more than saturates the 100 high value targets, so the cost of damage to U's high value is complete, or $C_{1vs} \approx K = 2$, as seen above.

As W falls, C_{1ms} also falls as suppression becomes lighter, but the cost of incomplete damage to P's military, C_{1mo}, increases as U's strikes become smaller. The two costs cross at about 1,250 weapons. As their changes largely compensate one aother, total military costs only fall a factor of ≈ 2. As bhigh value cost changes little, the first strike cost only falls to $C_1 \approx 2.4$. Figure 5 shows the components of U's cost for striking second, C_2, which have the same shapes and almost the same values as those of C_1.

Figure 6 shows the costs of reaching nodes 1 & 2, where P decides whether to strike first by comparing the costs of striking and inaction. The bottom curve is the cost of inaction, L + V = 0.5 + 1 = 1.5. The top two curves are those for a strike by U followed by a restrike by P. It is interesting that P's cost is slightly greater and parallel to U's, but it is more significant that both curves lie well above that of inaction for all W, which means the preferred choice at node 5 is inaction. As forces and preferences are the same for both sides, the preferred choice at nodes 3 and 4, 6, and 7 is also inaction, so the reductions are seen as quite stable by both sides. As the dominant contribution to C_1 is $C_{1vs} \approx K$, and the increment between C_1 and L + V = 1.5 is about 1 at W = 500, it is expected that stability is unaffected by reductions of K down to values of about unity.

Summary and conclusions. This note studies the sensitivity of strike incentives to deep offensive force reductions using exchange, cost, and game theoretic decision models derived and discussed in companion reports. As forces fall, weapon allocations shift from military to high value targets, with the shift being half complete at about 1,000 weapons. By 500 weapons, the first and second strikes are almost totally on high value.

The dominant cost for striking first is that of damage to one's high value, which is near total absent other constraints, and hence proportional to preferences for survival of high value. Changes in military costs are largely offsetting, so total first strike costs change little. The resulting costs at decision nodes are well above the costs of inaction, so the preferred course is inaction for all offensive reductions studied.

As the dominant cost for striking first is proportional to the preference for survival of high value. There is a wide gap between the first strike cost and that of inaction for the parameters studied here. These conclusions should be insensitive to

significant reductions in the preference for survival of high value, which is the most sensitive parameter.

References

[1] G. Canavan, "Cost of Addressing Targets of Unequal Value," Los Alamos National Laboratory Report LA-UR-01-draft, June 2001.

[2] G. Canavan, "Analysis of Decisions in Bi- and Tri-Lateral Engagements," U.S. *State Department Stability Workshop* (Institute for Defense Analysis, November 2000); Los Alamos National Laboratory Report LA-UR-00-5737, November 2000.

Fig. 1. Allocation of first and second strikes to missiles, military, and high value targets.

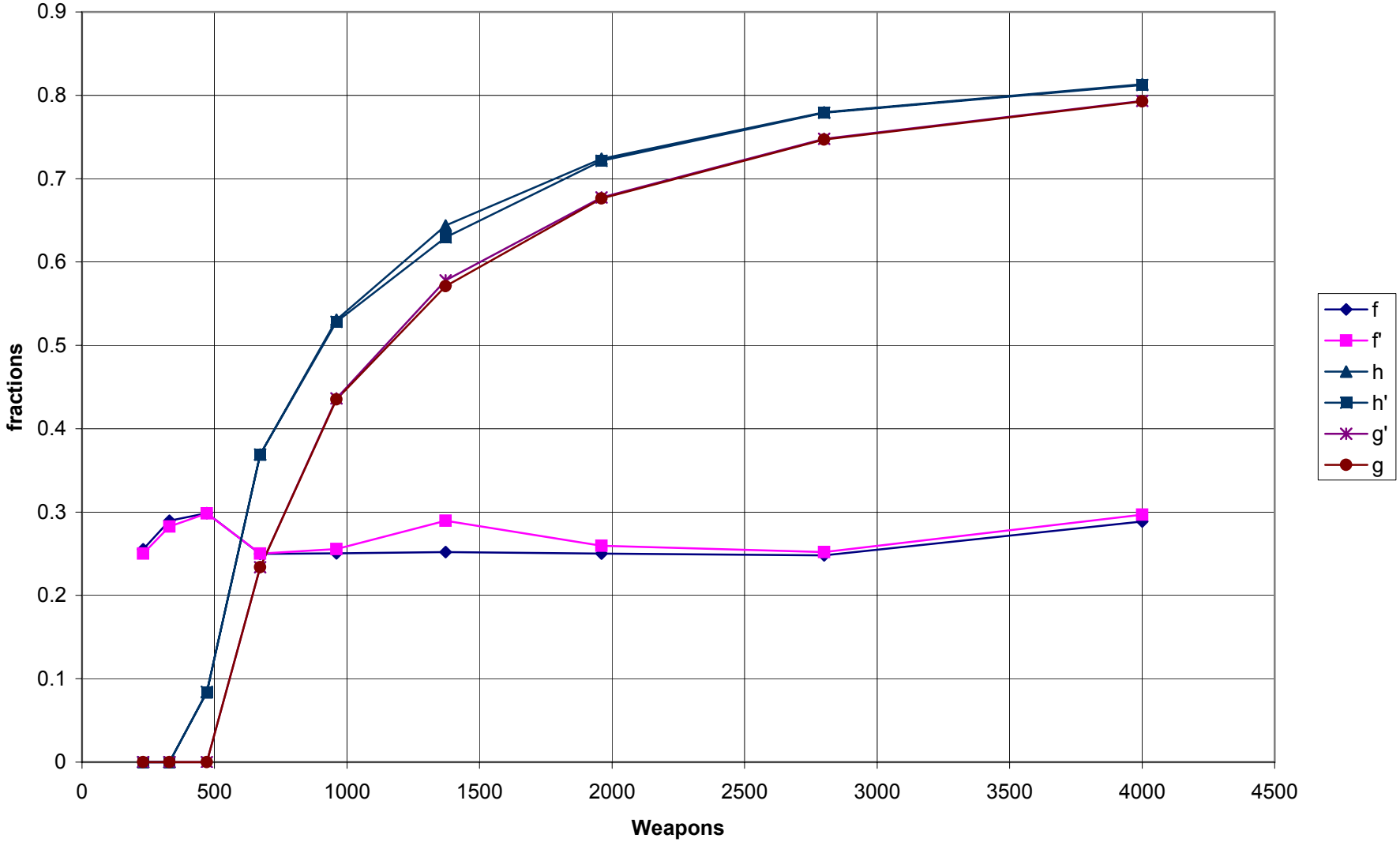


Fig. 2. First and second strikes as functions of total offensive weapons.

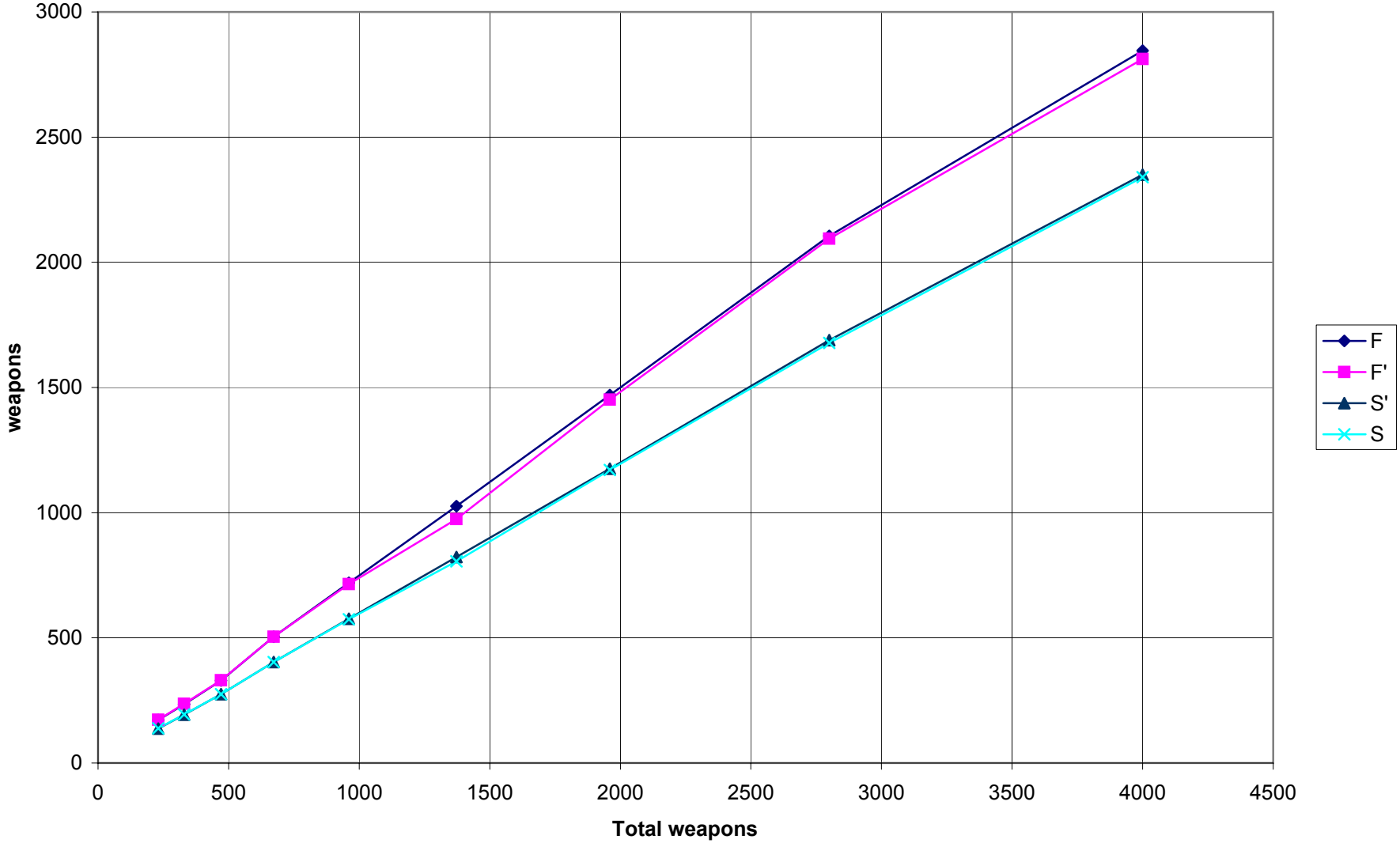


Fig. 3. First and second strikes on military and high value targets as functions of total weapons

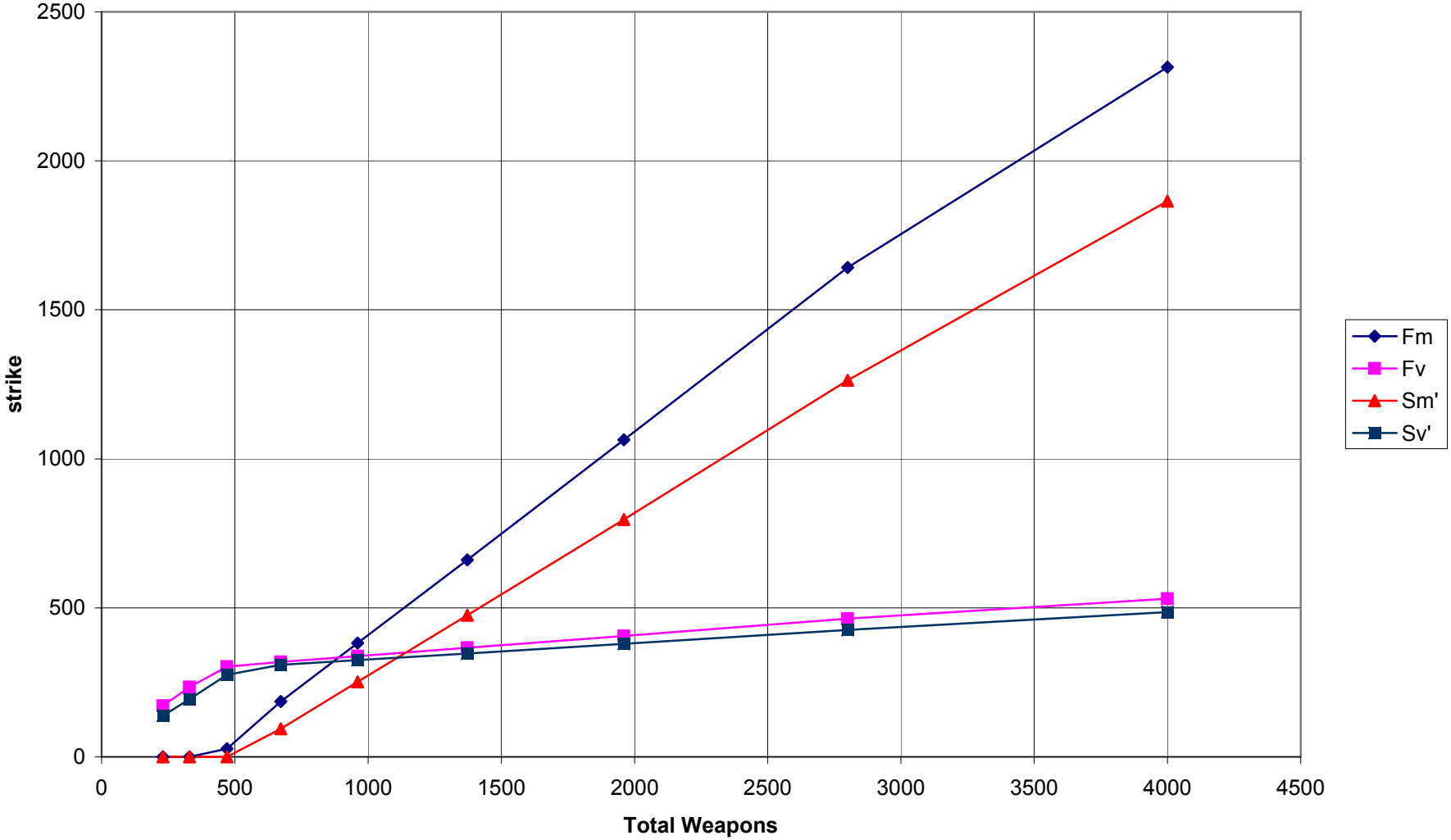


Fig. 4. First strike costs C1

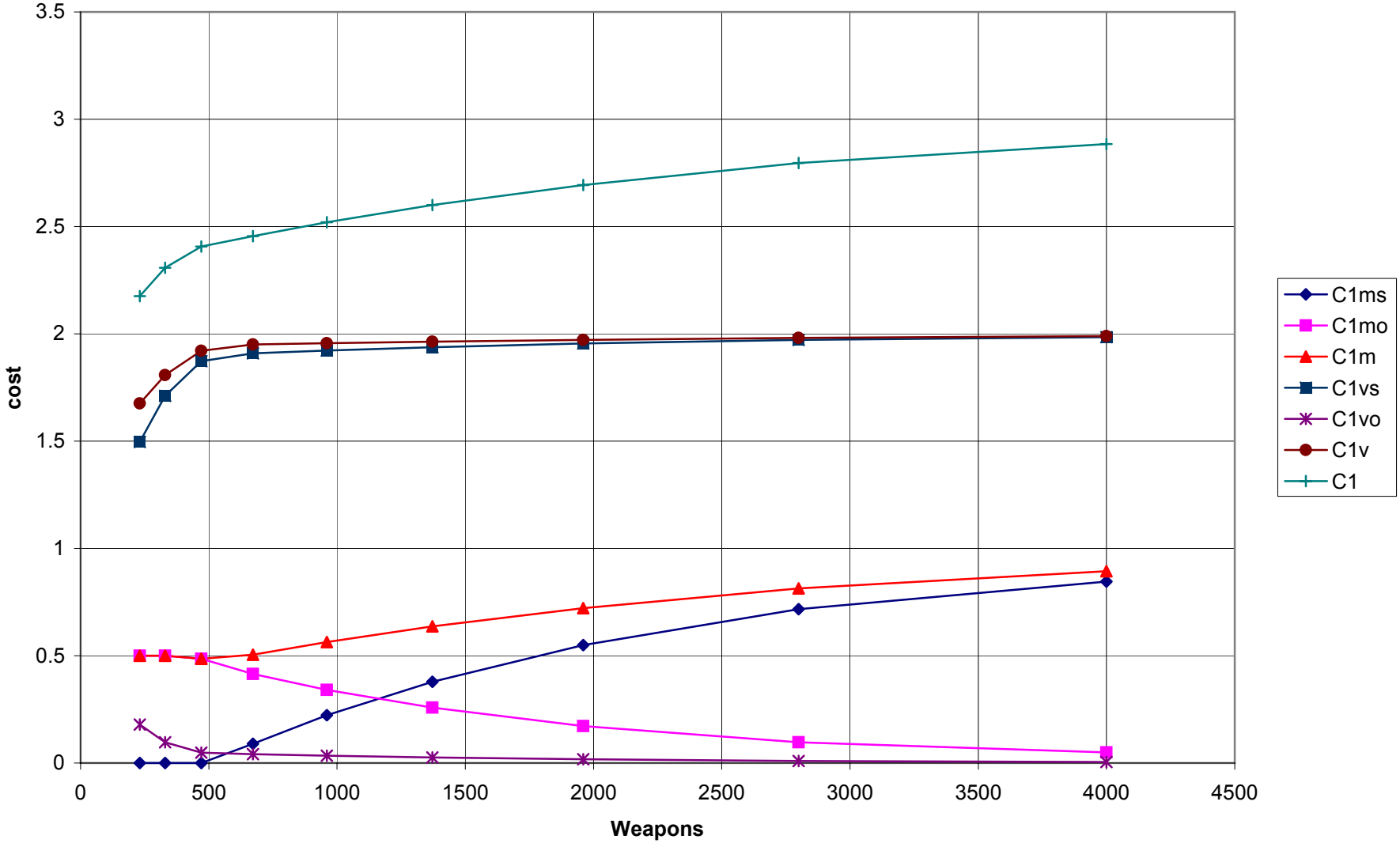


Fig. 5. Second strike costs C2

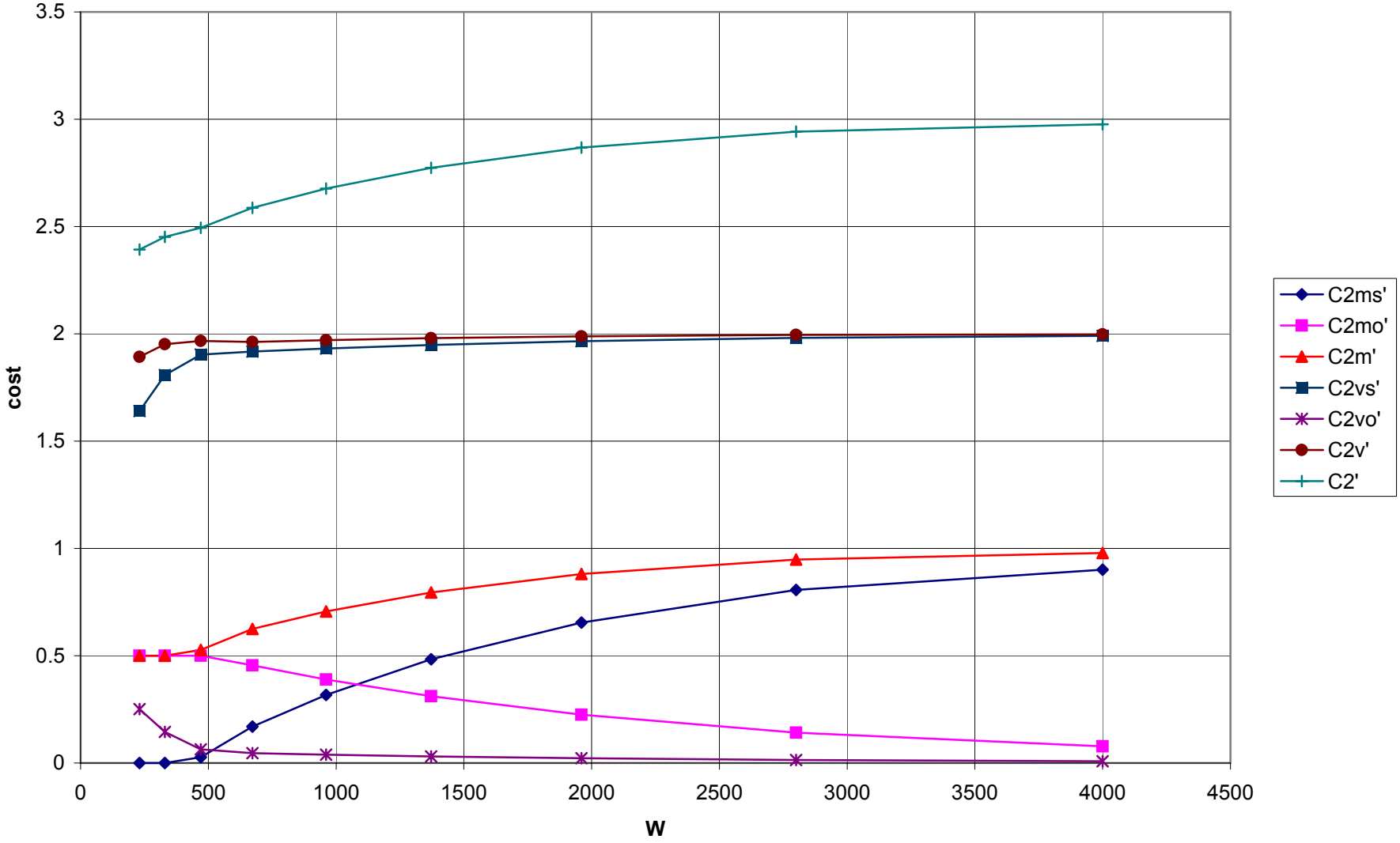
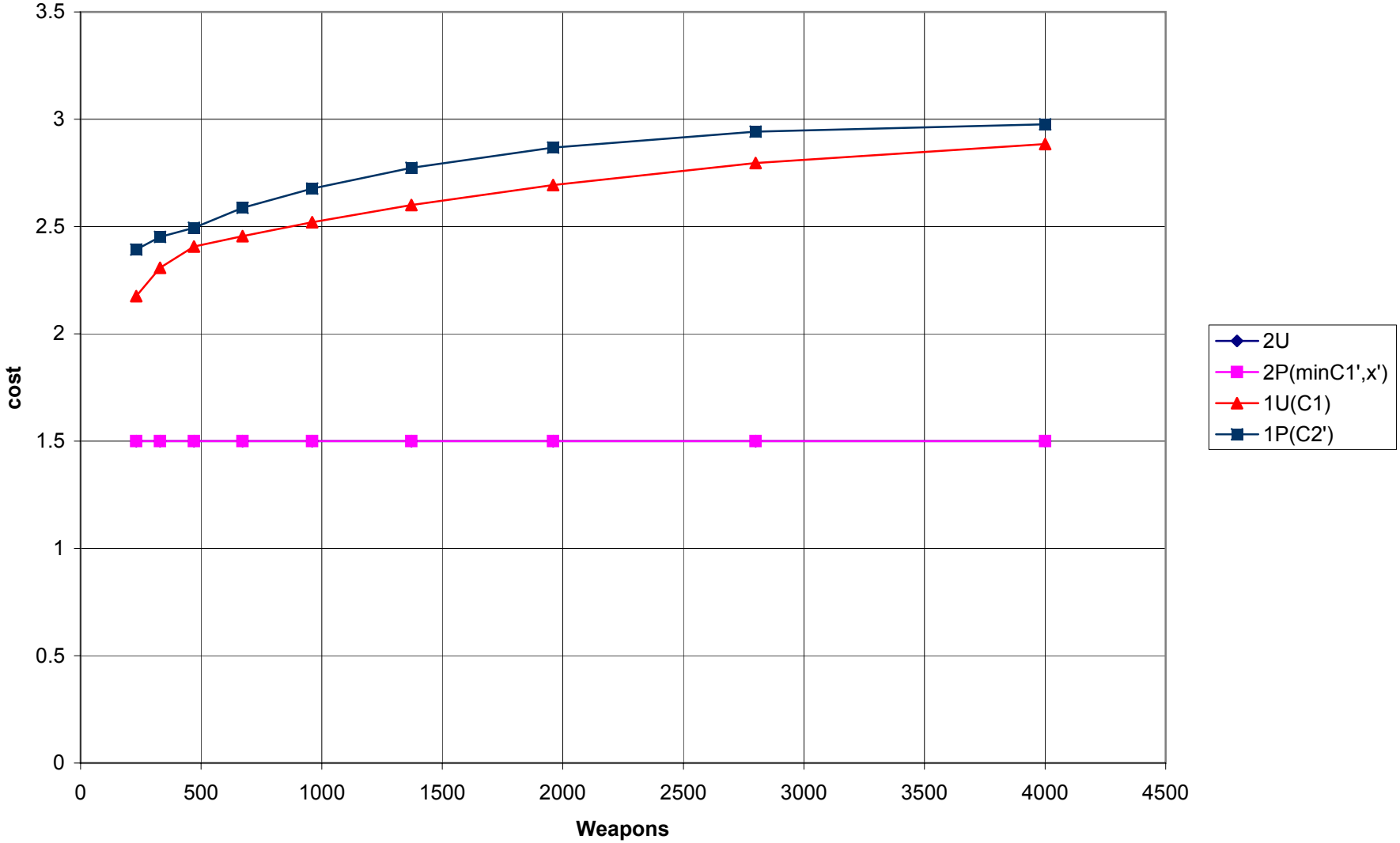
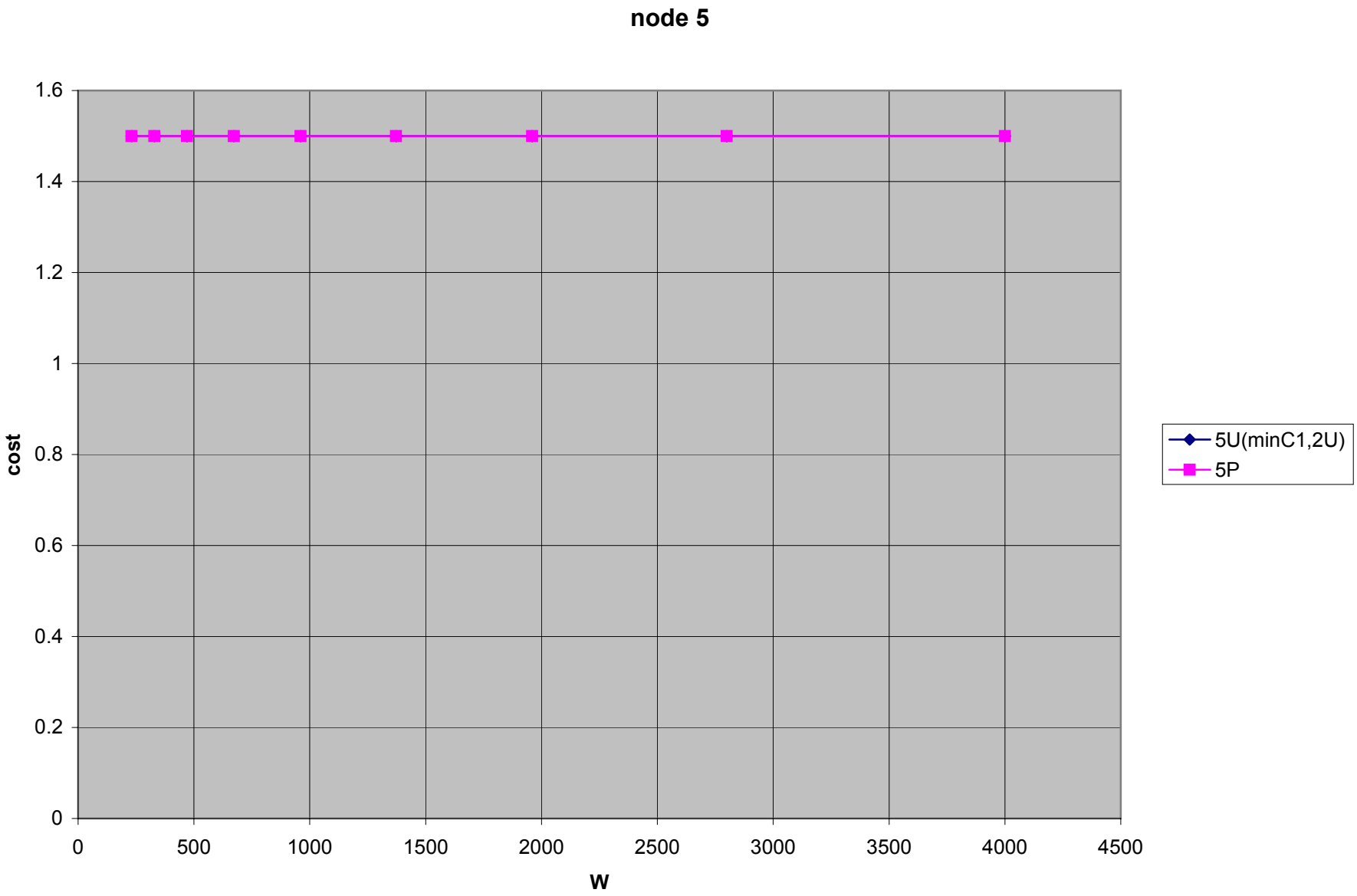


Fig. 6. Costs of reaching nodes 1 & 2

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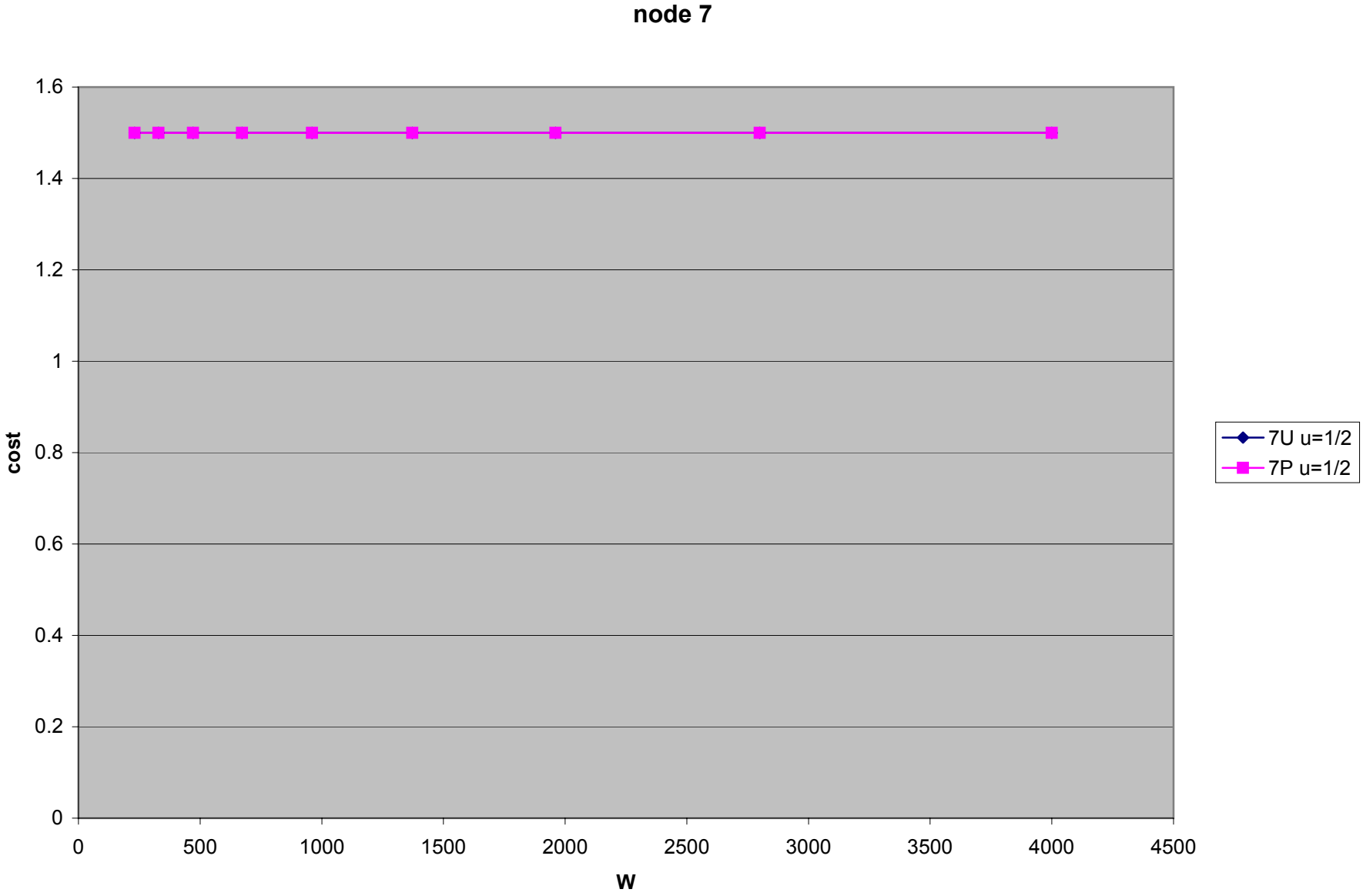
2500
3000
3500
4000
4500
w
5U(minC1,2U)
5P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2000
2500
3000
3500
4000
4500
w
7U u=1/2
7P u=1/2

p	q	#	0.7	m	M	n	N	W	l	p'	q'	m'	M'	n'	N'	W'	l'	f	f'	F	F'	h1	h	h'	r	int	Q'	Q'	S'	S	g1	g'	g	k	k'	v	v'	L	K	V	L'	K'	V'	Fm	Fv	Sm'	Sv'	Fm'	Fv'	Sm	Sv	C1ms	C1mo	C1m	C1vs	C1vo	C1v	C1	C1m	C1m	C1m'	C1vs	C1vo	C1v'	C1'	C2ms	C2mo	C2m'	C2vs'	C2vo'	C2v'	C2'	C2	W	u	L	C1	C2	L'	C1'	C2'	7U u=	7P u=	6U	6P(mi	4U(mi	4P	3U(C	3P(C'	5U(m	5P	2U	2P(mi	1U(C1	1P(C2')
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p'	q'	m'	M'	n'	N'	W'	l'	p	q	m	M	n	N	W	l	0	F'	h1'	h'	r'	int	Q'	S	g1	g	k'	k	v'	v	L'	K'	V'	L	K	V	Fm'	Fv'	Sm	Sv	C1ms'	C1mo'	C1m'	C1vs'	C1vo'	C1v'	C1'	C2ms	C2mo	C2m	C2vs	C2vo	C2v	C2
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